

[0044] FIG. 5C is a diagram showing sizes and pixel pitches of the image pickup regions of the image pickup apparatus shown in FIG. 5A;

[0045] FIG. 6A is a schematic diagram showing a structure of an image pickup apparatus according to another exemplary embodiment;

[0046] FIG. 6B is a diagram showing an example of image pickup regions of the image pickup apparatus shown in FIG. 6A;

[0047] FIG. 6C is a diagram showing another example of the image pickup regions of the image pickup apparatus shown in FIG. 6A; and

[0048] FIG. 7 is a schematic diagram showing a structure of an image pickup apparatus according to another exemplary embodiment.

DETAILED DESCRIPTION

[0049] Reference will now be made in detail to exemplary embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. In this regard, the present exemplary embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the exemplary embodiments are merely described below, by referring to the figures, to explain aspects of the present description. Expressions such as “at least one of,” when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list. It will be understood that when an element or layer is referred to as being “on” another element or layer, the element or layer can be directly on the other element or layer or intervening elements or layers may be present thereon.

[0050] FIG. 1A is a schematic diagram showing a structure of an image pickup apparatus 100 according to an exemplary embodiment. For example, the image pickup apparatus 100 may be a mobile device, such as a mobile phone, a tablet personal computer (PC), or a laptop PC. Referring to FIG. 1A, the image pickup apparatus 100 includes a first lens element 101, a second lens element 102, and a third lens element 103 having different diameters. In this example, the first lens element 101 has a first diameter, which is the smallest diameter, the second lens element 102 has a second diameter, which is larger than the first diameter, and the third lens element 103 has a third diameter, which is larger than the second diameter. Furthermore, the first through third lens elements 101, 102, and 103 are linearly disposed in a horizontal direction, when viewed from a rear, front, or surface of the image pickup apparatus 100. In this example, the third lens element 103 is disposed on the left, the first lens element 101 is disposed in the center, and the second lens element 102 is disposed on the right.

[0051] FIG. 1B is a schematic cross-sectional diagram showing an arrangement of the first through third lens elements 101, 102, and 103 and first through third image pickup regions 111, 112, and 113 of the image pickup apparatus 100 shown in FIG. 1A. Referring to FIG. 1B, the first through third image pickup regions 111, 112, and 113 respectively corresponding to the first through third lens elements 101, 102, and 103 are disposed. For example, the first image pickup region 111 is disposed on a focal plane of the first lens element 101, the second image pickup region 112 is disposed on a focal plane of the second lens element 102, and the third image pickup region 113 is disposed on a

focal plane of the third lens element 103. Therefore, the first through third image pickup regions 111, 112, and 113 form images by using light beams focused by the first through third lens elements 101, 102, and 103 respectively corresponding thereto. The first through third image pickup regions 111, 112, and 113 may include separate image sensors that are physically separated from one another, respectively. An image sensor may be a charge-coupled device (CCD) image sensor or a complementary metal oxide semiconductor (CMOS) image sensor.

[0052] The first through third lens elements 101, 102, and 103 may have the same focal length. Alternatively, as long as an internal space of the image pickup apparatus 100 allows, the first through third lens elements 101, 102, and 103 may have focal lengths that are different from one another. However, because differences between focal lengths may be insignificant due to a narrow space inside the image pickup apparatus 100, brightnesses of the first through third lens elements 101, 102, and 103 may be determined based on diameters of the first through third lens elements 101, 102, and 103. For example, an F number of the first lens element 101 with the smallest diameter may be 2.2, an F number of the second lens element 102 may be 1.5, and an F number of the third lens element 103 with the largest diameter may be 1.0. A theoretical size of a light spot focused by a lens element may be determined based on an F number of the lens element. In detail, as the F number of the lens element decreases (that is, as a brightness of the lens element increases), the size of the light spot may decrease. Therefore, a size of a light spot formed by the third lens element 103 with the smallest F number may be the smallest.

[0053] FIG. 1C is a diagram showing sizes and pixel pitches of the first through third image pickup regions 111, 112, and 113 of the image pickup apparatus 100 shown in FIG. 1A. Referring to FIG. 1C, the sizes of the first through third image pickup regions 111, 112, and 113 may be different from one another. In this example, the first and second image pickup regions 111 and 112 have the same first size, whereas the third image pickup region 113 has a second size smaller than the first size. As described above, because the focal lengths of the first through third lens elements 101, 102, and 103 are identical or similar to one another, angles of view are determined based on the sizes of the image pickup regions 111, 112, and 113. In this example, images obtained via the first and second image pickup regions 111 and 112 have the same first angle of view, whereas an image obtained via the third image pickup region 113 has a second angle of view narrower than the first angle of view. Therefore, the third image pickup region 113 provides a relative telescopic zoom, compared to the first and second image pickup regions 111 and 112. In other words, the first and second image pickup regions 111 and 112 provide a first zoom corresponding to a relatively wide angle of view, whereas the third image pickup region 113 provides a second zoom corresponding to a relatively telescopic angle of view. Therefore, the image pickup apparatus 100 provides a zoom function including the first zoom (wide angle) and the second zoom (telescopic angle).

[0054] Furthermore, FIG. 1C shows pixels 121, 122, and 123, which are respectively same-sized portions of the first through third image pickup regions 111, 112, and 113 magnified at the same magnification. As shown in FIG. 1C, the first through third image pickup regions 111, 112, and 113 have different pixel pitches from one another. In this